"A river seems

a magic thing.

A magic, moving,

living part of the very

earth itself."

Laura Gilpin

KEY RESULT AREA 2

Waterway Corridor Management

Desired Result: *Waterway corridors that function to minimize flood-induced loss of life, protect property and floodplain ecology, preserve natural stream channel stability, provide recreational access, and support healthy aquatic and riparian ecosystems.*

What does waterway corridor management mean? We recognize that our waterway corridors — streams, rivers, lakes, and their adjacent, interdependent landscapes serve multiple functions. Efforts must be integrated to manage these corridors as:

- Natural resources for conveying flood waters
- High quality waters for safe recreational enjoyment
- Cultural and historical amenities for our communities
- Habitat for diverse and productive biological communities

Why is waterway corridor management important? Traditionally, the approach to managing waterway corridors has tended towards single-issue programs: wetland protection; stream encroachment limits; structural flood reduction projects; regulation of floodplain development; and site-specific recreation and access projects. More recently, knowledge of the diverse functioning of stream corridors has improved. This better understanding of the multiple functions waterway corridors serve needs to be incorporated into our decision-making.

For example, when a transportation project to span a waterway is designed, care must be taken to ensure the structure does not negatively impact or impede the natural ability of the corridor to convey floodwaters, transport sediment, and minimize erosion. Innovations in bridge design and structural flood control, floodplain property acquisition, accurate floodplain mapping, stormwater management, streambank restoration, and floodplain regulations aimed at achieving the standard of *No Adverse Impact* all can contribute to protecting or restoring stream corridors.

Waterway corridors are necessary for flood management. Flooding occurs in all watersheds and along coastal areas. Flooding in undeveloped watersheds is part of natural hydrologic variability, and while it may be temporarily damaging, it provides benefits to the ecosystem. Floodwaters carry mineral-rich sediment, which improves soil productivity when deposited upon the floodplain. Where watersheds and floodplains are developed, flood damage is primarily due to the placement of structures and human activities within an area susceptible to flooding. Changes in land cover within a watershed frequently increase the area susceptible to flooding. Building occupied structures within a floodplain ensures vulnerability to flood hazard, property damage, and potential loss of life. Existing floodplain development has made adequate flood warning a priority in order to provide lead-time for emergency actions to prevent loss of life and property. In Figure 9, the topographic floodplain represents the uppermost limits of flood water levels associated with storm events. This level is much higher than the flood levels that maintain and shape natural stream channels, as explained below:

- The hydrologic or riparian flood level maintains riparian wetland communities (a return period of 2 to 20 years).
- Bankfull flood levels transport the majority of a stream's natural sediment load and shape the dimensions and patterns of natural streams (return period of 1 to 1.5 years).
- Stream base flows maintain the habitat of aquatic organisms during low flow periods and are entirely supported by ground water discharge.

It is crucial to manage not only for extreme floods that threaten lives and infrastructure, but also for the riparian flood, the bankfull flood, and base flow conditions. Impacts of development, such as stormwater runoff and stream encroachment, can alter the frequency and energy of these more frequent floods, which in turn affect wetlands, natural channel stability, and fisheries.

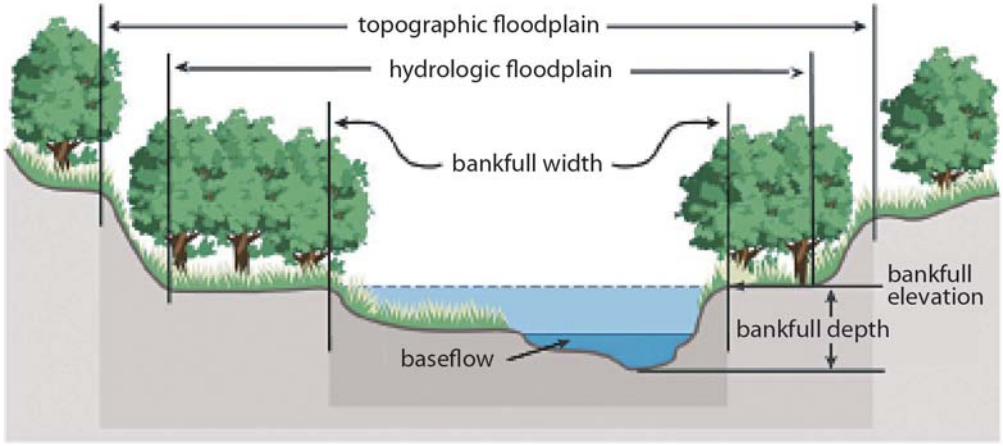
The Basin's waterways are important recreation venues and community amenities. Rivers and lakes of the Delaware River Basin are located within a day's drive of about 20% of the U.S. population. The Basin includes National Wild and Scenic Rivers, the Appalachian Trail, and numerous game lands, parks, and forests.

Recreational activities range from passive (such as wildlife or landscape photography) to active (hiking, fishing, trapping, hunting, canoeing, boating, white-water rafting). It includes activities along the waterways as well as on or in the waters. Waterway use is dependent on adequate public access along the streams, rivers and the Bay. Insensitive use of the waterways, streambanks and trails can impair both the visual and functional value of the resource. Physical and visual access to water, whether for recreation or inspiration, adds dimension to our quality of life and enhances the attractiveness of our communities.

Waterway corridors provide essential aquatic and riparian habitat. Waterway corridors function as transportation networks and food sources for wildlife, and provide habitat for shelter and propagation for aquatic and terrestrial species of plants and animals. Forested buffers provide temperature control, keeping the water cool and shaded from sunlight. This helps maintain a more constant environment for temperature-sensitive species, and stabilizes dissolved oxygen levels. Vegetation also helps to stabilize stream banks, reducing erosion and minimizing disruption to aquatic habitats. Fallen trees provide woody debris that serves as a refuge for aquatic species.

Excessive high flows and inconsiderate recreational use can physically impair waterway corridors, threatening the health

Figure 9: Cross-sectional Illustration of a Waterway Corridor
(Source: Stream Corridor Restoration: Principles, Processes, and Practices, Federal Interagency Stream Restoration Working Group, 1998)



of natural ecosystems. Making our waters "fishable" means creating an aquatic environment supportive of healthy fish and wildlife, as well as having finfish and shellfish safe for human consumption.

Goals for Waterway Corridor Management

2.1 Prevent or minimize flood-induced loss of life and property, and protect floodplain ecology.
2.2 Enhance water-based recreation in the river and its tributaries.
2.3 Protect, conserve and restore healthy and biologically diverse riparian and aquatic ecosystems.

GOAL 2.1: Prevent or minimize flood-induced loss of life and property, and protect floodplain ecology. Identifying areas and structures within a community that are at risk from flooding is the single most important step in mitigating future flood damage and loss. Community planning to reduce flood damage is critical, and guidance is available from federal and state agencies to help communities in this effort. In addition, flood forecasting and warning, maintenance of flood control structures, and stormwater management are all essential elements of controlling future flood damage.

Assessing flood hazards. Flood hazard information must be made available to communities so they can identify structures at risk and develop mitigation plans. This should include methods that can help communities plan to prevent structural loss.

Developing pre- and post-development mitigation strategies. The Disaster Mitigation Act of 2000 requires municipalities and states to develop hazard mitigation plans in order to remain eligible for post-disaster mitigation grants. Pre-development strategies might include floodplain management, stormwater management, and property acquisition along stream corridors. Post-development strategies might range from maintenance of existing flood control structures to elevation or removal of buildings from the flood hazard area by property relocation or buy-out and demolition. In addition, streambank restoration could follow building relocation or demolition.

Linking flood control and stormwater management. Coordinating flood mitigation and stormwater management involves a vast array of agencies, departments, offices and programs at all levels of government. A more detailed assessment of this challenge is in "Key Result Area 4: Institutional Coordination and Cooperation."

Taking steps to minimize the ecological impacts of floods. Landscape alterations that occur with human settlement include intrusions into the floodplain — including structures, roads, bulk heading, and the filling of wetlands — that can interfere with both watershed hydrology and the floodplain's ability to convey water. Damaging erosion and deterioration of stream channels, and the associated ecological consequences, can be minimized through a combination of regulations and responsible development decisions for stormwater and floodplain management and wetlands preservation.

2

WHAT IS A WATERWAY CORRIDOR?

A waterway corridor is a stream, river, or lake, and the portion of its adjacent landscape that directly affects and is affected by its hydrology and ecology. The Basin's waterway corridors connect to create networks, enabling a variety of species to migrate between aquatic and terrestrial environments, and from one region of the Basin to another.

Waterway Corridor Management

Stormwater control and flooding. The practice of removing stormwater from a site as quickly as possible, or controlling its peak flow rate but not its volume, combined with the extensive clearing of forested land that historically precedes human settlement, has altered the hydrology of many watersheds in the Basin, severely in some instances. The importance of stormwater management to reduce both ecosystem and property damage, along with steps to improve our current system of management, is explained in greater detail in "Key Result Area 3: Linking Land and Water Resource Management."

Enhancing flood forecasting. No matter what assessments and mitigation strategies are implemented, adequate warning with regard to impending or potential flood events remains the key to minimizing loss of life in flood events. The accuracy and reliability of hydrologic forecasting depends on adequate monitoring of precipitation and stream flow. In support of enhanced flood forecasting and warning capabilities, funding should be secured for the implementation of "Recommendations to Address Flood Warning Deficiencies in the Delaware River Basin," prepared in May 2002 by the Delaware River Basin Commission, with technical guidance from the DRBC Flood Advisory Committee.

Increasing awareness. Community leaders, residents and developers need to be informed about the natural functions of waterway corridors in flood mitigation, the risks that accompany inappropriate development in the floodplain, and the need for hazard mitigation and stormwater management plans to mitigate hazardous conditions or prevent them from occurring.

Table 1: The Benefits of Buffers
(Source: Alliance for the Chesapeake Bay, 1996)

Leaf Food	• Leaves and woody debris provide food and habitat for insects, crustaceans, amphibians and small fish
Filtering Runoff	• Buffers slow runoff and settle out sediment, nutrients and pesticides before they reach streams and lakes
Infiltration	• Rates in vegetated buffers can be 10-15 times higher than grassed turf and 40 times higher than plowed fields
Canopy and Shade	• Leafy canopies provide shade, keeping water cool, retaining dissolved oxygen, and favoring the growth of beneficial algae and aquatic insects
Habitat	• Wooded corridors provide the most diverse habitats for fish and other wildlife, especially valuable for birds
Nutrient Uptake	• Fertilizers and other pollutants are stored in limbs and roots • Bacteria in the forest floor convert excess nitrate to nitrogen gas which is released into the air

GOAL 2.2: Enhance water-based recreation in the river and its tributaries. The Basin's National Wild and Scenic Rivers, the Appalachian Trail, and numerous game lands, parks and forests can be linked to optimize recreational experiences.

Creating a Delaware Basin recreational use and access plan. The need exists for regional recreational use and access planning that provides for overall integrated management of recreation and tourism, protects water resources from recreational impacts, provides enjoyment and convenient access, and

protects the health and safety of recreational users. A Basin-wide recreation and tourism plan should include strategies to:

- Promote the Basin as a tourist destination
- Provide additional public access to waterways
- Create a linked water trail system
- Increase the scope and frequency of stream and river trash collection
- Maintain or improve recreational water quality
- Avoid impacts from recreational use
- Improve the connections of communities to their waterways

The streams and rivers of the Basin are attractive natural transportation routes. However, they are often isolated from one another, located on or very near private property, or lack access sites or safety features. Hazards abound near urban areas, in the vicinity of dams, and where high-speed roads and railroads share space with recreational users. Generally, few amenities are available to travelers along water corridors.

Inconsiderate recreational use can degrade environmental quality, especially through physical impacts to sensitive riparian ecologies. Challenges lie in understanding thresholds and, where necessary, setting limits to human use.

Coordinated efforts are needed to expand access and enhance the recreation experience of the river-using public. Numerous entities in the Basin are involved in providing recreation and tourism services, yet regional connections are lacking between towns along waterways; between user and provider communities; and between states. Implementation of recreation and tourism objectives requires a serious coordination effort by public and private entities.

Promoting visual and physical access to waterways in community development plans. This requires concerted efforts to educate developers, officials, and the public about the opportunities waterway corridors can offer for recreation, and the need to promote access through local planning. Legal barriers to increasing public access need to be investigated.

Developing operating plans for reservoirs. Public and private reservoirs serve a variety of important purposes, including public water supply, power generation, flow augmentation and flood control. They also provide recreational opportunities (both at the facilities and downstream). Facility functions can be prescribed by statute and/or subject to regulatory approvals of the Delaware River Basin Commission, the Federal Energy Regulatory Commission or other agencies, and their operating plans must reflect their prescribed functions.

GOAL 2.3: Protect, conserve and restore healthy and biologically diverse riparian and aquatic ecosystems. The health of plant and animal communities requires that flows in rivers and streams exhibit the natural range of variation in the flow regime, especially seasonally. Other physical and chemical parameters are also critical to the health of ecosystems. Understanding the range of needs for the diverse native aquatic and riparian populations within the Basin is a major challenge.

Defining flow regime and water quality criteria to support healthy aquatic and riparian communities. Ecosystem needs for flow and water quality vary seasonally with the

HOW DEVELOPMENT EXACERBATES FLOOD IMPACTS

Flood waters that would be retained in the headwaters or allowed to spread into the floodplains are quickly transported by the conduits of paved roadways or storm sewer pipes directly into the waterway. Overburdened with flood water, the water gains speed and power, picks up sediment and debris, and rushes down waterways too constricted by development to function properly. This increases scour on the sides and bottom of waterways, uprooting plants and eliminating substrate for bottom-dwelling species.

life cycles of aquatic and riparian species. Criteria are dependent on topography, elevation, and geology, and are specific to the assemblages of populations in a region, a watershed, or a stream's reach.

Additional investigation of the fresh water inflow requirements for estuarine ecosystems is needed. In the tidal portion of the Basin, present policy consists of meeting a flow target for the Delaware River at Trenton, New Jersey. The target is designed to maintain the 30 day average chloride concentration at or below 180 ppm at river mile 98 during repetition of drought-of-record conditions to protect industrial and potable supply needs. Currently a model is used to forecast salinity changes based on projected changes to the flow regime. The freshwater inflow needs of estuarine systems should be established and incorporated into flow scenario evaluations, and up-to-date information on climate change and sea level rise should be used when evaluating projected estuary conditions.

Incorporating ecosystem requirements in water quality criteria and flow targets. The Basin states are using biological and physical criteria in addition to traditional chemical criteria for assessment and protection of aquatic life. There has been increased monitoring of biological assemblages, habitat conditions, stream morphology, and riparian conditions to determine overall ecological integrity of the Basin's waters. Coordination and cooperation among agencies and non-governmental organizations is necessary to effectively assess and manage the Delaware River and its tributary watersheds. This includes establishing minimum water quality and flow criteria to support consistent designated uses throughout the Basin. These criteria will not just be the minimum acceptable for the survival of adults, but adequate to support and protect all life stages and the reproduction of aquatic and riparian communities.

Establishing a regional approach to sediment management. Sediment transport occurs when soils are eroded by moving water. Results of sediment transport can be beneficial or problematic. Floodwater deposition of rich alluvial soils can be a boon to agriculture, while sediment deposits in navigable waterways can block channels and create dangerous conditions for river traffic. Erosion of upland soils can result in the loss of tons of fertile topsoil into bays and oceans, increasing turbidity and smothering benthic habitat.

Managing sediment requires paying attention to the "source" of eroded soils as well as the "sink" or place of deposition. Management of soil sources includes a variety of practices to keep soils from eroding (see discussions on stormwater management in "Key Result Area 3: Linking Land and Water Resource Management"). Management of soil "sinks" includes dredging unwanted sediment from ports and navigable channels, removing contaminated sediments from ecological systems and removing sediments to restore habitats. Managing sediments in a systems context has not been widely practiced, but regional sediment management is being increasingly recognized as a strategy for effective ecological and economic control of sediment as a valuable resource.

A regional approach to sediment management uses sediment budgets, which include sediment sources and sinks and the identification of ongoing sediment management activities performed throughout the watershed. Sediment availability is linked with sediment needs within the system based on suitable quantity, quality,

and timing. Through planning and coordination, such varied activities as navigable channel maintenance, habitat restoration, abandoned mine rehabilitation and beach nourishment projects can all be made more efficient and economical.

Employing restoration techniques to improve impaired waters. Restoring hydrological and ecological function requires investments in research and agency support, but they can be successfully accomplished with major benefits to water resources and habitat. Environmental restoration is a relatively new field, and information needed to determine objectives and predict ecological response to restoration measures is sparse. Restoration of landscapes and waterways is presently as much an art as a science. Sharing information helps advance our understanding of restoration techniques.

Protecting riparian and aquatic ecosystems. Commercially significant species thrive on a food base of non-game mammals, birds, fish, reptiles, amphibians, mussels, and invertebrates supported by the Delaware River and Bay. It is important to identify and protect the habitat and life stage requirements of key commercial, recreational, game, non-game, threatened, and endangered species so they survive and successfully reproduce throughout their natural ranges. Water flows and quality, the absence of non-native predators or competitors for habitat and food, and the abundance of food supply are all integral to the success of our native aquatic and riparian plants and animals. Limits on harvesting may be necessary to ensure a sufficient number of reproducing adults and the abundance of commercial species for future generations.

Invasive species management. Identifying invaders, their means of distribution, and methods of controlling them offers a tremendous ecological and economic challenge. It also challenges the ability of our institutions to work cooperatively, since it requires supportive efforts among agencies, organizations and individuals in the fields of science and research, environmental protection, commerce, and transportation.

- **Competition from invasive species is second only to habitat loss in its impact on ecosystem integrity.**

This Key Result Area covers the importance of waterway corridors, both as the interface between the land and surface waters of the Basin, and for the numerous functions they provide to humans and aquatic communities. The quality and quantity of our water resources are affected by conditions and activities that may occur far from the actual water bodies. "Key Result Area 3: Linking Land and Water Resource Management," looks at how the entire watershed, including its varied landscapes and land use activities, functions as a critical component of the hydrologic system, and how our management and decision-making structure can improve results for better water resource management.